

Anti-icing Teflon Cover

Evaluation report



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1 Introduction

The aim of this document is to provide a feedback on the test of a new anti-icing system for Microwave antenna. The test takes place mainly on Titlis (Engelberg OW_3006D) during winter 2008/2009. This document provides as well an overview of this new anti-icing system.

2 Description of Anti Icing Teflon cover

Teflon cover is an alternative anti-icing system destined to replace the heating system to present in use on OCH network. This system is made with a cover enveloping the Microwave antenna and maintained by rope. The cover is made from Teflon material and his design is adapted to the shape of the Antenna.

The Teflon material has the propriety to repel liquid water and present a high resistance to UV radiation and harsh climatic conditions. The idea is to use the hydrophobic propriety of the Teflon material to avoid that the snow and ice stick on the front of the dish during snow storm and result in outage of the microwave link.

Due to the exceptional chemical stability the Teflon (polytetrafluoroethylene or PTFE) has many applications in chemical and nuclear industry. This material is used also in textile industry and enters in the composition of many goods of usual life.

The rope used to maintain the Teflon cover is UV resistant as well as the thread used to assembly the pieces of the envelope.



Figure 1 - Anti-icing Teflon cover

3 Test of Teflon cover vs heating system

3.1 Context of the test

In order to test their efficiency it has been decided to fit the microwaves antennas of tests site with Teflon cover. The Titlis (OW_3006D) has been selected by Orange as presenting the harshest conditions on Orange network. During the installation it has been proposed by ALU to install a Teflon cover on two antennas in order to benchmark Teflon covers with the heating system.

All antennas of the Titlis have the same bearing. This parameter is important to compare the efficiency of both anti-icing systems because the direction of the wind is a key factor of icing phenomenon.

An additional cover has been installed on the Stockhorn (BE_9847B). However, the purpose was to remove the heating belt suspected in case of lightning to converge in damages of microwave equipment.

Link Id	MW	Tested antenna					Remote end			
		Antenna	End	Site Id	Rank	Bearing	End	Site Id	Rank	Bearing
Titlis										
15789	Ericsson	1,2	B	OW3006D	6	332	A	OW3000A	2	152
15790	Ericsson	0,6	A	OW3006D	2	329	B	OW3003A2	1	149
18806	Andrew	1,2	A	OW3006D	5	300	B	OW8023A	1	120
25476	Andrew	0,6	A	OW3006D	3	331	B	OW0003B	11	151
Stockorn										
19094	Andrew	1,2	B	BE9847B	1	8	A	BE9935A	3	188

Tabelle 1 - List of the MW link equipped with Teflon cover **part of the trial**

An additional microwave link (Id 26587) has been installed on Titlis during the test but without being included in the test.

The heating system of the dish where the Teflon cover has been installed was switched off and the electrical connections removed from the connection plot in order to avoid a reactivation of the heating system by error.

Instruction has been given to the people on site to not clean OCH antennas, or only on explicit request from ALU. Unfortunately we have no guaranty that the technical staff in charge of infrastructure in Titlis had followed our instructions.

3.2 Impact on Microwave Link

The level of signal receive on both extremity has been controlled before and after the installation of the Teflon cover in order to verify that no perturbations are related to the installation. The idea was also to verify that the Teflon cover doesn't have any effect on Microwave signal propagation.

Example on link 25476 OW3006-OW0003 NEC below:

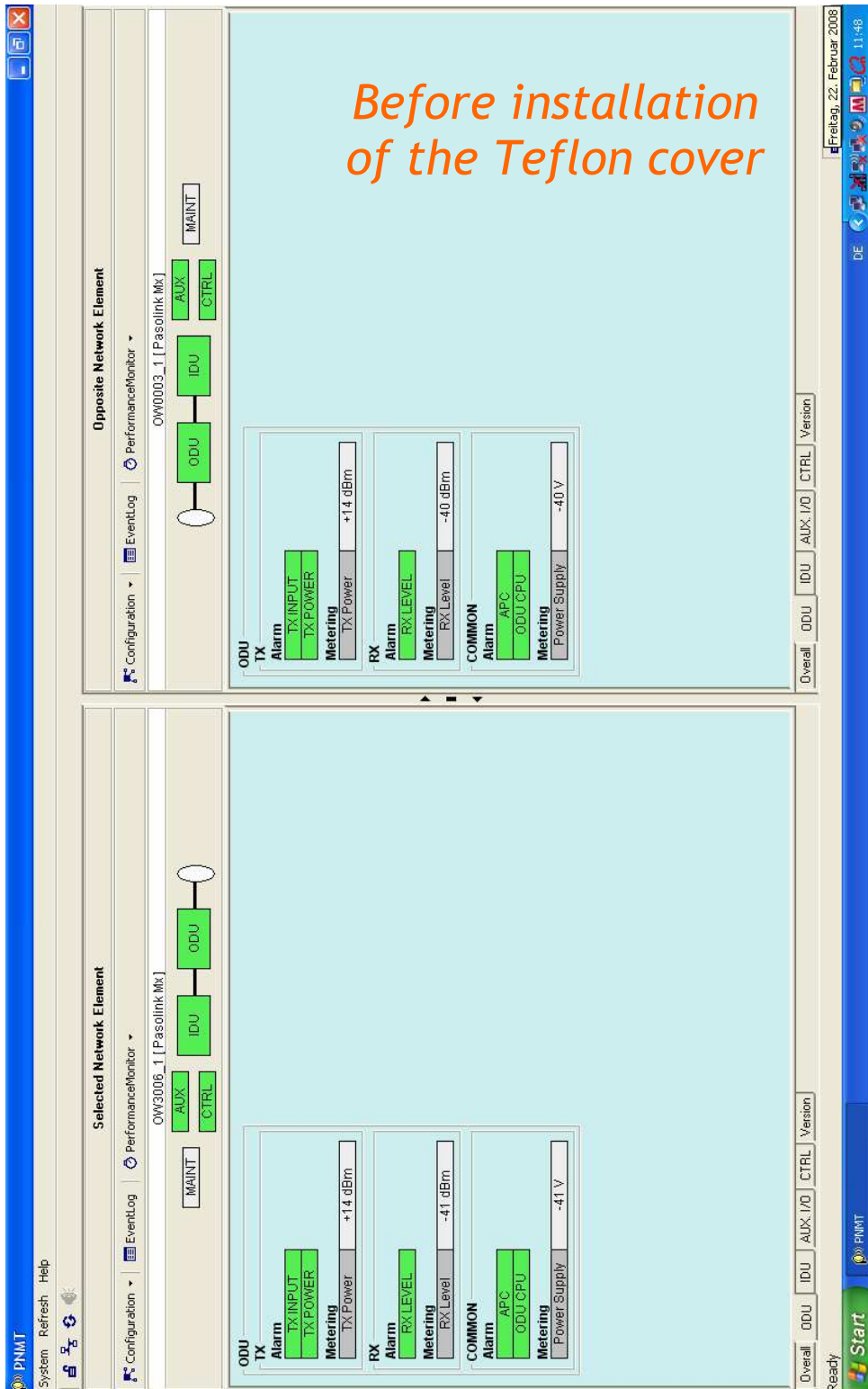


Figure 2 - Levels before installing Teflon cover

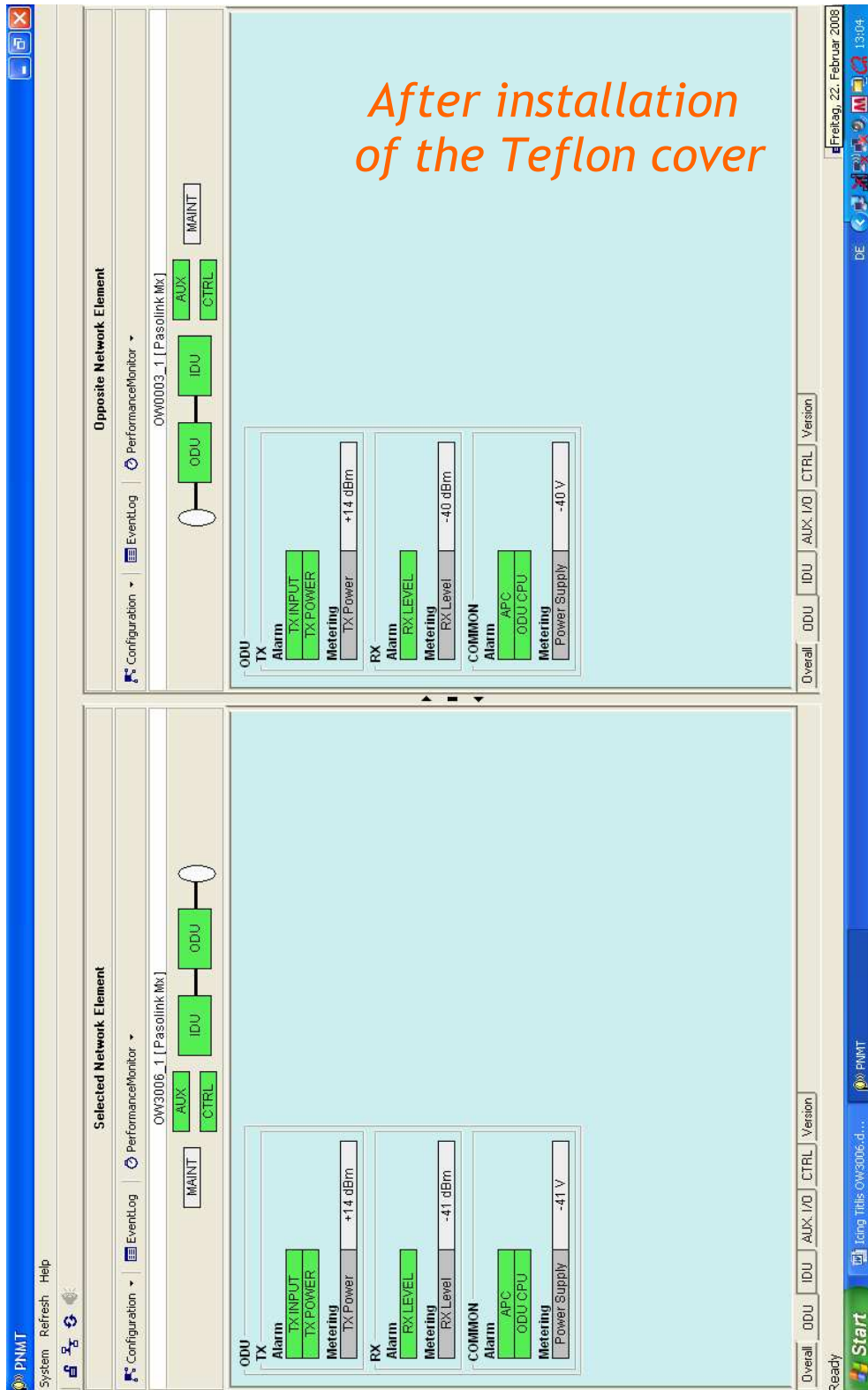


Figure 3 - Levels after installation of the Teflon cover

No degradation of the signal level were found, which confirm that the Teflon cover have no significant negative impact on the Microwave link quality of service.

4 Assessment of anti-icing systems

Benchmarking with heating system is based on comparison of photos taken on site just after or during snow storm and the alarms forwarded and stored in NETACT. Observation period start on the 01/10/2008 and issue on the 31/03/2009. Data from météoSwiss are considered as non reliable by Orange and will be excluded from the present survey.

Unfortunately this project had suffered from a poor cooperation of the peoples from technical services of Titlis despite few meeting on site and constant demands by phone. We discover late that a microwave part of the trial is supervised though a modem and all attempts to recover the alarms history failed due to disconnection. In addition due to the limited Alarm buffer of the NEC microwave it wasn't possible to recover the alarm history.

4.1 Visual assessment

The pictures below were taken on 25/12/2008 after a snow storm. They show an accumulation of blowing snow on the front of both dishes fitted with heating system or Teflon cover. Then we can conclude to a draw, but we learn that in harsh conditions (low temperature, high wind) the snow can stick on Teflon.



Heating system

Teflon cover

Figure 4 - Titlis dishes on 25/12/2008

4.2 Assessment based on Alarm history

4.2.1 Warning

The following survey is based on MW Alarm history of a single site (Titlis) during 6 months. A limited number of events are available to understand the behaviour of the anti-icing systems, therefore the conclusion below shall be considered with caution. In addition the reader must understand that antenna icing is influenced by numerous factors like:

- Orientation of the antenna relatively to the wind blowing during snow storm.
- Position of the antenna on the structure and his exposition to the turbulences generated by the structure.
- Speed and direction of the wind.
- Temperature (during snow storm) and temperature curve.
- Unsolicited human's inter-actions (dish cleaning).
- Diameter of the dish.

Considering the above mentioned and the conditions of the trial, we believe that the information collected give an indication on the behaviour of the anti-icing systems in harsh conditions. Indeed, the Titlis was selected as the site offering the harshest conditions for a MW in OCH network, but this site is not representative of the overall MW sites in OCH Network.

To compare these tow system or to evaluate the performance of the Teflon cover with accuracy in a single trial, the test should be performed in controlled environment (wind tunnel). In order to determine the conditions that lead to dish icing and asses with accuracy the impact on the network. To guaranty an impartial comparison, the factors involved in dish icing shall be controlled and the experimental conditions shall be reproducible on demand.

The other possibility more in line with OCH and ALU possibility is to compare the behaviour of tow group of test sites. One test group gathered MW antennas fitted with Teflon covers and the other group gathered antennas fitted with heating systems. Both test groups shall present similar characteristics repartition and profile (Dish size, bearing, altitude, geographical repartition, etc.).

4.2.2 Alarm consolidation and service outage

Assessment is based on MW alarms collected from NETAC and consolidated in order to compare the total time of service outage. The period of observation start on 1st October 2008 until the 31 march 2009.

During the observation period, no incidents on the MW or heating system part of the trial were logged in Remedy except the TT328104. This TT is related to the replacement of an ODU on OW8023 after an outage of one week due to a problem with the site access. It is assumed that all other alarms notifying a RF signal attenuation and traffic outage are the consequence of the antenna icing.

The **Table 2** show alarms and traffic outages with a duration superior to 30 seconds. However the total outage correspond to the sum of all the outages > and < to 30 seconds. Excelsheet including all alarms and calculation is available below and the log file from NETACT is available on demand. Note that outages exceeding 24 hours in the table below mean that the outage is going on the next following days.

A end - B end: Vendor/Dish: Anti Icing	OW3000 Ericsson Teflon cover	OW3006 1.2m	OW3006 Ericsson Heating system	OW3003 0.6m	OW3006 Nokia Heating system	OW8023 1.2m
Date	Alarms	Outage	Alarms	Outage	Alarms	Outage
01/10/2008						
07/10/2008	3	0:00:28			10	0:03:49
10/10/2008	4	0:03:06				
22/10/2008	2	8:49:48				
23/10/2008	3	28:49:27				
30/10/2008	10				21	0:03:10
03/11/2008	2	0:33:59			13	164:24:47
19/12/2008	366	0:43:34	253	1:35:05	8	0:06:54
20/12/2008	289	0:34:29			6	0:08:44
21/12/2008			178	1:23:40		
01/01/2009	2	23:35:36				
15/01/2009	4	0:14:26				
01/02/2009			1	1:36:42		
06/02/2009			2	0:53:29		
07/02/2009			1	6:17:21		
08/02/2009			1	14:41:19		
10/02/2009			2	2:49:19		
15/02/2009			1	0:37:07		
16/02/2009	1	0:00:21	3	0:07:36		
25/02/2009			7	0:06:53		
26/02/2009			3	14:31:20		
27/02/2009			2	14:58:20		
01/03/2009			4	19:38:42		
02/03/2009	1	0:00:32	17	15:48:57		
03/03/2009			2	8:21:54		
04/03/2009			9	0:21:14		
10/03/2009	2	1:59:16			7	
12/03/2009	5	0:09:03				
14/03/2009	1	0:00:16	3	0:01:19		
16/03/2009	3	0:13:47	4	0:00:43		
18/03/2009	3	25:34:04	5	0:02:17		
Totaux		91:37:05		103:57:26		164:47:24

from 19/12/09 till 31/03/09 **53:12:49**

Tabelle 2 - Outage overview

No alarms were reported on the link 15790 between the 01/10/2009 and the 19/12/2009. This lack of alarms is suspect as well as the low number of alarms/events reported on the link 18806 along the trial. Therefore the link 18806 and the period between 01/10/08 and 19/12/08 will not be considered in the assessment.



Alarm_consolidation_
dish-icing

The total outage show and advantage to the Teflon cover. Compared to the link 15790 on the same period (19/12/08 to 31/03/09) the outage is 50% inferior with the Teflon cover.

4.2.3 Evolution of the Teflon cover along the time

After 16 months being installed on Stockton a recent visit on 16 June 2009 hasn't shown any damages on the Teflon cover.



Figure 5 - Teflon cover from Stockhorn 16 months after installation

Teflon cover is made from a simple Teflon envelope. The simplicity of the concept and the resistance of the Teflon material guaranty an excellent longevity and limited maintenance.

However the longevity of the Teflon cover has to be demonstrated in the next coming years. Seam and ropes could represent a weakness of the Teflon cover. Thread and rope are reputed UV resistant.

5 Summary of benefits and weak points

5.1 Benefits of Teflon cover

Consumption: The power consumption is most probably the topic that draws the attention of OCH on Teflon cover. The Teflon cover is a passive system

and doesn't require any kind of power source. This could allow OCH to save a consequent amount on MW OPEX.

In addition the Teflon cover is not sensible to power outage.

Efficiency: This trial has given an overview of the efficiency of the Teflon cover. It appears that both system fail in case of extremely low temperatures. The alarm list let appear that the Teflon cover totalise less outages periods. A possible reason is that the Teflon cover freeze at lower temperature than the heating system. The Alarm list let appears that outages are is shorter with heating system. A possible explanation is that the heating systems "unfreezes" quicker or at lower temperature than the Teflon cover. Due to the trial conditions and limited resources, the hypothesis above shall be considered carefully.

Installation: Installation of the Teflon cover is quiet much simple and quicker, this is a benefit for installation and maintenance. Teflon cover is a passive system and doesn't require 220 AC power up to the MW antenna.

Maintenance: Teflon cover is made from a simple Teflon envelope. The simplicity of the concept and the resistance of the Teflon material guaranty an excellent longevity and limited maintenance. However this have to be confirmed in the coming next years, but a recent visit on Stockhorn shows that the Teflon cover doesn't present any damages or alterations after 16 months passed on site.

Reusability: Once installed the elements of the heating system like the heating belt or the power cable could not be reused easily. The Teflon cover could be easily removed from an antenna and reinstalled on the same model of antenna somewhere else.

5.2 Benefits of Teflon cover

Unfreezing: The Alarm list show that the dish fitted with the heating belt present outages period more often but shorter. This could come from the gap of temperature bring by the heating system on the front of the dish.

The eating system brings a gap of temperature on the front of the dish between 13 and 20 degrees depending of the dish model and corresponding heating belt. The temperature on the front of the dish corresponds to the outdoor temperature added to gap of temperature bring by the heating system:

Outdoor temp. + gap of temp from heating syst. = temps on surface of the dish)

It is easy to understand that when the temperature on the surface of the dish fall under zero, blew snow can stick on the dish. And when the temperature on the front of the dish goes over zero degree the snow melt (ex: outdoor temp. = -17°C, heating syst. temps = 17 °C => Temps front of the dish = 0°C).

This could represent a big asset as cold temperatures currently stand for awhile in high summits and lot of sites are not reachable in winter when the weather is bad. Consequently the MWs fitted with heating system will support a limited outage compared to the MWs with Teflon cover.

- Supervision:** The heating systems are supervised through RAN equipments which forward an alarm indication to NMC in real time. This allows operation to repair the fault most of time before any traffic outage.
- Spare parts:** Most of the time the defect is due to partial destruction of the heating belt. The heating belt is less expensive than a Teflon cover, however the longevity of the Teflon cover has to be considered. To present we have no indication on life expectancy of Teflon cover.

6 Conclusion

As conclusion we could say that the Teflon cover presents many advantages and works as an anti-icing system within certain limits. The Titlist and Stockhorn trial have demonstrated a higher efficiency of the Teflon cover compared to the heating system. In addition the Teflon cover presents an important saving potential for OCH.

However as it is stated above the conclusions are based on few events of a trial based on two sites. External factors, like the position on the structure, human interactions, etc. could have influenced the result. We should bear in mind that the anti-icing systems were installed on sites over 2000 metres and most of them have restricted access during winter. Prudence will command to extend the trial to 20 or 40 sites following the criteria defined in the chapter 4.2.1.

The lessons learned show that in order to guarantee a good collection of information and processing this kind of long term trial shall be supported by a large panel of experts (Transmission optimisation, network configuration, Field service, network monitoring etc.). Information related to the status of MW and anti-icing system, alarms, operation shall be collected and processed on daily bases.